DOCUMENT RESUME

ED 151 199 SE 023 983

TITLE Aquatic Plants and their Control.
INSTITUTION Michigan State Dept. of Natural Resources, Lansing.
PUB DATE [77]
NOTE 12p.; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Botany; Ecology; *Environment; *Herbicides; Land Use; *Natural Resources; *Plant Science; *Science Education; *Water Resources
IDENTIFIERS *Aquatic Plants

ABSTRACT

Aquatic plants can be divided into two types: algae and macrophytes. The goal of aquatic plant management is to maintain a proper balance of plants within a lake and still retain the lake's recreational and economic importance. Aquatic plant management programs have two phases: long-term management (nutrient control), and short-term management (direct manipulation of algae and macrophyte populations). Some of the principles and techniques of long- and short-term aquatic plant management are discussed. (Author/BB)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED151199

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

William J. Mullendore

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

# Aquatic Plants and their control

IC-4853

SE 023 163

# Aquatic Plants and their Control

## INTRODUCTION

Aquatic plants are a vital part of any lake or pond. They convert by the process of photosynthesis, with the aid of sunlight, chemical elements into living plant tissue. Then they themselves are utilized by bacteria and animal life (zooplankton, fish, waterfowl, insects, and water mammals) as food for energy. The process of photosynthesis also replenishes the aquatic environment with oxygen, which is essential to aquatic animals. Additionally, rooted plants create a varied aquatic environment in which fish-food organisms reside. They are also associated with the reproductive activities of certain fish, and furnish protection for young animals and fish.

Although they are important to the aquatic environment, plants frequently conflict with man's recreational and economic interests. A need, therefore, exists for proper aquatic plant management to insure that the natural environment and man's interests are mutually protected. The Department of Natural Resources, Inland Lake Management Unit, which administers the state laws regulating the application of herbicides to aquatic environments, has developed this bulletin as a primer for those seeking information on aquatic plant management.

# Aquatic Plant Types

The proper management of aquatic vegetation requires a knowledge of the various plants that grow in lakes and ponds. Although aquatic plants may be divided into many categories, a simple classification according to life forms and growth patterns divides them into two divisions: the algae and the macrophytes.

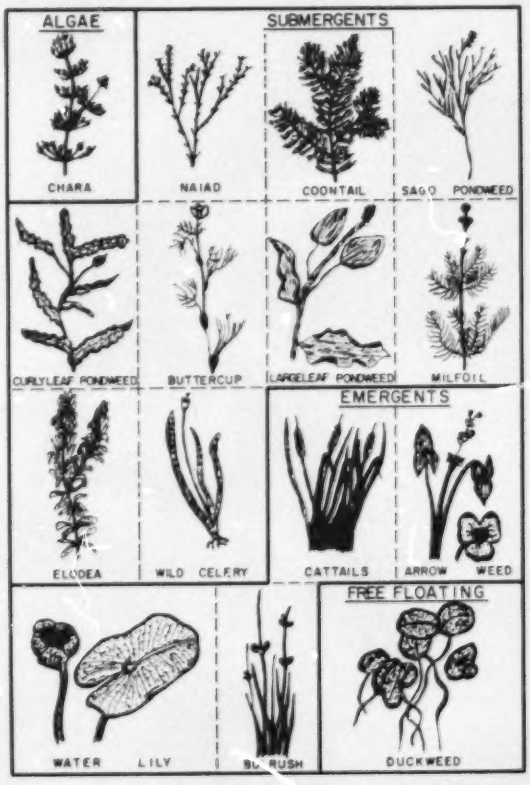
## Algae

Algae are divided basically into planktonic, filamentous and macro-algae forms. Planktonic forms are microscopic, free floating plants often referred to as "water bloom". In large numbers, these algae can cause water to appear green, brown, yellow or even red, depending upon the species present. Filamentous algae, commonly called "pond scum", can form raft-like masses over the water surface, but since they are vulnerable to winds and currents, they are generally restricted to bays, bayous and sheltered shorelines. Filamentous algae can also grow attached to the lake bottom, the macrophytes, or piers and docks. Many attached filamentous algae will frequently detach from the substrate and form floating mats. The macro-algae include the two types referred to as Chara and Nitella which are large and resemble macrophytes.

## Macrophytes

The macrophytes may also be divided into three basic forms: submergent, emergent, and free-floating. Submergent macrophytes usually grow rooted to the bottom with stems and leaves below the water surface, except for some plants which may produce a few small floating or aerial leaves. These plants are often referred to as seaweed, lake grass or moss. Emergent macrophytes (including large floating leaf plants with attached roots) grow in shallow areas along the shoreline, with most of the plant extending out of the water (e.g. water lilies, cattails). Because of their restricted habitat (shallow water areas) these plants usually cause only localized problems. The only free-floating macrophytes which may be a problem in Michigan waters are the duckweeds. These tiny plants are not attached to any substrate, but float freely within or upon the water. They are subject to current and wind action which will concentrate them in certain portions of a lake where they can be a localized problem.

Identification of the aquatic plants present in a lake is important for proper plant management since control measures that are effective against one plant type may not be effective against another. Schematic drawings of a few plants which are commonly found in Michigan are presented in Figure 1. Additional help in identification of aquatic plants is available from: (1) county extension agents, (2) chemical companies dealing in aquatic herbicides, (3) universities, (4) Department of Natural Resources' district offices, and (5) licensed aquatic pesticide applicators.




COMMON AQUATIC PLANTS OF MICHIGAN LAKES
(PLANTS NOT DRAWN TO SCALE)

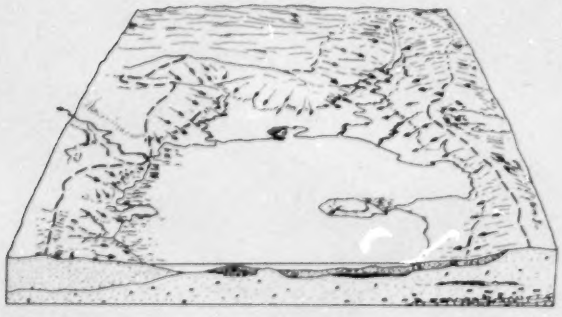
Figure 1

# Why Aquatic Plants Grow

The distribution and abundance of aquatic plants in a lake is dependent upon the lake's chemical and physical properties including:

1) the quality and quantity of light available,
2) water levels,
3) water temperatures,
4) particle size of lake bottom sediments,
5) current or wave action, and
6) the concentration of dissolved gasses and nutrients.

In lakes, nutrients and light availability are most often the requirements which limit plant growth. Nutrients are the chemicals such as nitrogen, phosphorus, carbon, potassium, etc., which plants require for their growth. These nutrients originate in the rocks and soils surrounding the lake. Natural processes at work within the lake's watershed continually carry some of these nutrients into the lake. A lake's watershed is the land around the lake from which water drains to the lake (Figure 2). Lake watersheds vary greatly in size, topographic relief and the means by which water moves through the watershed (stream flow, groundwater movement, surface runoff, etc.). The natural movement of nutrients to lakes is therefore dependent upon the characteristics of the watershed.



DIAGRAMATIC REPRESENTATION OF A LAKE AND ITS WATERSHED THE BROKEN LINE REPRESENTS THE DRAINAGE DIVIDE OF THE WATERSHED THE ARROWS DEPICT THE PATTERN OF OVERLAND FLOW

Figure 2

As nutrients move from the watershed, lakes naturally develop an ability to produce aquatic plants. Limnologists (lake scientists) have for many years grouped lakes by a classification system based upon their productivity or ability to produce plants. Lakes that are low in productivity are called oligotrophic, while lakes high in productivity are called eutrophic. Oligotrophic lakes usually:

1) are deep,
2) have high oxygen concentrations in the deeper water,
3) are very clear,
4) have sparse populations of aquatic plants, and
5) are populated with cold water fishes such as trout and whitefish.

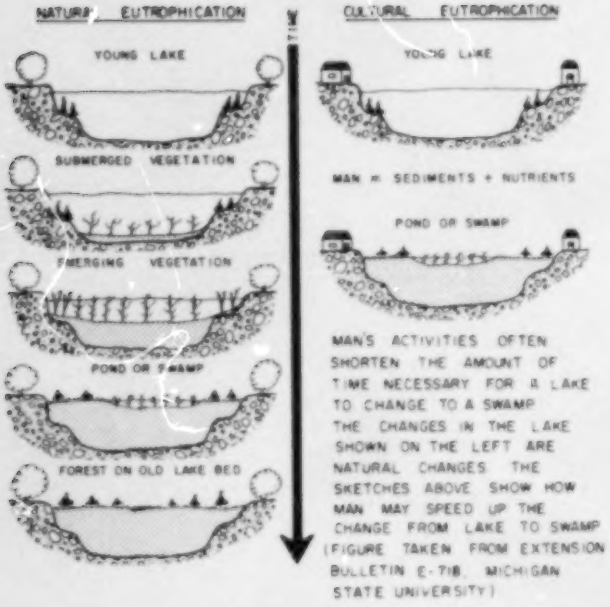
Eutrophic lakes usually:

1) are shallow,
2) have little oxygen in waters deeper than 30 feet,
3) have murky water,
4) have substantial growths of aquatic plants, and
5) are populated with warm water fishes such as bass, pike, and bluegills.

The term mesotrophic is often used to describe a lake with characteristics between oligotrophic and eutrophic.

Over geological time (thousands of years) oligotrophic lakes may very slowly age into mesotrophic and eutrophic lakes. This aging process of lakes is referred to as eutrophication. The rate at which eutrophication (aging) proceeds in any given lake is primarily based upon the quantity of nutrients and sediments washed into the lake from its watershed.

Without the presence of man, lake aging is usually a very slow process requiring many thousands of years. However, the presence of man in a lake watershed can greatly accelerate aging. This greatly accelerated rate of aging is often referred to as "cultural eutrophication" and is caused by the increased amount of nutrients and sediments put into lakes as man changes (development) their watersheds (Figure 3). Consequently, what man does to the land within a lake's watershed can greatly influence the growth of aquatic plants in the lake.


NATURAL EUTROPHICATION
CULTURAL EUTROPHICATION
YOUNG LAKE
SUBMERGED VEGETATION
EMERGING VEGETATION
POND OR SWAMP
FOREST ON OLD LAKE BED
YOUNG LAKE
MAN = SEDIMENTS + NUTRIENTS
POND OR SWAMP
MAN'S ACTIVITIES OFTEN SHORTEN THE AMOUNT OF TIME NECESSARY FOR A LAKE TO CHANGE TO A SWAMP THE CHANGES IN THE LAKE SHOWN ON THE LEFT ARE NATURAL CHANGES THE SKETCHES ABOVE SHOW HOW MAN MAY SPEED UP THE CHANGE FROM LAKE TO SWAMP (FIGURE TAKEN FROM EXTENSION BULLETIN E-718, MICHIGAN STATE UNIVERSITY)

**Eutrophication**

Figure 3

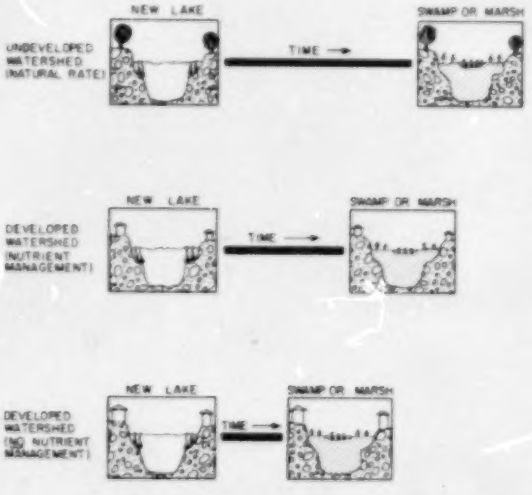
# *Aquatic Plant Management Program*

The goal of aquatic plant management is not to "kill weeds" but to maintain a proper balance of plants within a lake and still retain the lake's recreational and economic importance. Ideally, every aquatic plant management program will have two phases: (1) long-term management (nutrient control) and (2) short-term management (direct manipulation of macrophyte and algae populations). Short-term management is relatively easy to implement, but long-term management is more complicated. It requires considerable community involvement and cooperation, and results take years rather than days to develop.

The remainder of this bulletin will consider the principles and techniques of long-term and short-term aquatic plant management. Not every principle or technique presented will be applicable to every lake and even those that are should be evaluated carefully before using them. While economics must, of course, be considered, ecological values should receive prime consideration before employing any management technique. Attention to ecological values may result in a program that is less costly over the period of a decade or two.

# *Long-Term Management (Nutrient Control)*

Aquatic plants require many nutrients for growth and reproduction. The nutrients most often considered to be in the shortest supply and therefore limiting plant growth are phosphorus and nitrogen. Since aquatic plant populations are directly dependent upon the amount of nutrients available, nuisance growths of plants are only symptoms of high nutrient levels. This is important because all too often aquatic plant control programs are directed only at the aquatic plants, and not at what causes the plants to grow (nutrients). An effective aquatic plant management program must give proper consideration to the amount of nutrients entering the lake. Aquatic plant management techniques designed only to "kill weeds" must be considered only temporary cosmetic measures to reduce the symptoms of high nutrient levels. It is wiser to control the movement of nutrients on the watershed, whenever possible, then to attempt remedial action after nutrients have entered the lake. Although the management of nutrient sources cannot, over the long run, prevent the lake from becoming a marsh, it can reduce the rate of lake aging (Figure 4).




EUTROPHICATION (AGING) OF LAKES WITH DIFFERENT LEVELS OF NUTRIENT LOADING

Figure 4

Limiting the movement of nutrients off the watershed and into lakes will require the management of nutrient sources. Some sources of nutrients both natural and man-made are listed in Table 1. Natural sources of nutrients are those which would contribute nutrients to a lake even if man were not present. Most natural sources contain only very small amounts of nutrients. However, man-made sources of nutrients usually have large volumes and high concentrations of nutrients which can greatly accelerate the rate of lake eutrophication.

All nutrient sources will have different levels of manageability. Some may be uncontrollable, while others may be controlled with little effort or cost. Ideally, it is desirable to know which sources are contributing nutrients to a lake and in what quantities. It is then possible to adjust funds and activities to control nutrient sources to most effectively reduce the amount of nutrients entering the lake. However, this approach in most situations will require an extensive study by a trained limnologist.

The best time to begin a nutrient control program is before aquatic plants have attained nuisance levels, for proper management of a lake requires considerable long-range planning. The management of nutrient sources is an on-going responsibility, which must be intensified as man continues to develop the watershed. Methods of nutrient source management include:

1) proper land use,

2) wise consumer use of commercial products,

3) treatment of inflowing waters high in nutrients,

4) diversion of waters high in nutrients, and

5) municipal and industrial wastewater treatment.

Proper Land Use

The importance of proper land use and watershed planning is beginning to stimulate many units of government, at all levels, to enact ordinances and laws to regulate land use. In Michigan, the State Legislature enacted the Soil Erosion and Sedimentation Control Act of 1972 (Act No. 347 of the Public Acts of 1972) to limit the movement of sediments and associated nutrients into surface waters during earth moving activities (except agricultural tillage).

Minnesota, Wisconsin and Maine now require local government units to establish zoning ordinances for lake and stream front properties to protect the quality of these aquatic environments. Table 2 presents land use practices that should be considered in a nutrient control program.

Wise Consumer Use of Commercial Products

There are several commercial products, such as detergents and fertilizers, used for domestic and commercial purposes which can contribute significant amounts of nitrogen and phosphorus to natural waters. Curtailing or restricting the use of these products or substituting similar products of low nitrogen and phosphorus content would substantially reduce the loading of nutrients to natural waters.

Waterfront property owners should take special care in the use of detergents and fertilizers. Owners with individual septic systems should minimize the use of high phosphate detergents to prevent leaching of phosphorus into the lake by way of the groundwater. Additionally, waterfront property owners should avoid the use of lawn fertilizers. If fertilizers must be used, the soil should be tested to determine which chemical nutrients are needed. If the soil does not require phosphorus, a fertilizer containing little or no phosphorus should be used. County cooperative extension agents can provide information on soil testing procedures and the best dates for applying fertilizers.

Treatment of Inflowing Waters High in Nutrients

In certain situations it may be possible or necessary to treat inflowing waters to reduce nutrient levels before they enter a lake. An inflowing stream or drain may carry substantial amounts of nutrients collected from many sources, such as agricultural drainage or urban stormwater drainage. In certain situations it may be more feasible to chemically or physically treat the inflowing water to reduce nutrients than to control the many diffuse nutrient sources draining into it.

Diversion of Waters High in Nutrients

Diversion is the rerouting of water high in nutrients around or away from a lake. The principle of diversion is applicable to most nutrient sources that can be physically contained or rerouted. The application of this nutrient control technique has been most frequently applied to the diversion of municipal wastewater, but the concept can apply to waters containing high nutrient levels derived from other sources as well.

In many cases where nutrient rich water has been diverted away from a lake, there has been a marked increase in water quality. It must be emphasized, however, that diversion is not a substitute for treatment or proper land management. The diversion of non-treated nutrient rich waters is only a transfer of nutrient control problems to downstream communities.

Municipal and Industrial Wastewater Treatment

Few Michigan inland lakes receive municipal wastewater discharge, but when present, it can be a major source of nutrients for aquatic plant growth. Several methods are now available to reduce the level of plant nutrients in wastewater. But even when these methods are used, a wastewater treatment plant discharging to a lake or its tributaries will contribute greatly to the loading of nutrients to a lake. Diversion of wastewater around lakes or land disposal are possible alternatives for eliminating completely the impact of this nutrient source upon lakes.

Industrial wastewater is highly variable in quality. Those that contain substantial amounts of plant nutrients or toxic materials must be considered in any lake management program.

Table 1. Natural and man-made sources of plant nutrients (chemical elements) to the aquatic environment.

| Natural | Man-Made |
|---|---|
| wetland runoff | domestic and industrial wastewater |
| meadow land runoff | agricultural runoff (cropland & pasture) |
| forest runoff | agricultural wetland drainage |
| precipitation on the lake surface | managed forest runoff |
| soil erosion | urban stormwater runoff |
| aquatic bird and animal wastes | septic tank discharges |
| leaf, pollen and dust deposition | landfill drainage |
| groundwater influxes | construction activities |
| nitrogen fixation by plants | lake shore lawn runoff |
| sediment recycling | atmospheric fall-out of wind borne fertilizers from land and industry |

(Modified from Shannon and Brezonik, 1972. Relationship between lake trophic state and nitrogen and phosphorus loading rates. Environ. Sci. Tech. 6:719-725).

Table 2. Examples of wise land use practices which can reduce the movement of nutrients from the watershed into lakes.

a. Advocate sediment control from logging, agricultural activities and urban construction.

b. Preserve wetlands as no development areas.

c. Require or encourage greenbelting to preserve native vegetation along lake and stream banks.

d. Promote proper collection and disposal of or treatment of farm and feedlot animal wastes.

e. Encourage sound farm fertilization practices.

f. Urge community collection and disposal of leaves in urban areas adjacent to large recreational water systems.

g. Require routine inspection and maintenance of catch basins in city storm drains.

h. Limit or restrict the use of fertilizers on lawns adjacent to lakes and streams.

i. Prevent urban stormwater drainage, with its high nutrients, from directly entering a lake, rather encourage subdivision designs which maximize infiltration and groundwater recharge.

j. Regulate the size and use of lake and stream front lots and back lots to prevent overdevelopment of the environment and its associated high nutrient loading.

k. Stipulate a minimum distance of at least 100 feet between the shoreline and installation of private septic systems and tile fields.

l. Prevent development in areas where the groundwater is high or soils are poor nutrient traps for private sewage-disposal systems.

m. Require an environmental impact statement for all development which could significantly degrade environmental quality.

# Short-Term Management of Aquatic Plants

Although the initial and continuing phase of aquatic plant management should be the control of nutrient sources, many lakes have such serious plant problems that short-term management techniques may be needed to protect the recreational and economic interests in the lake. Also in cases where nutrient control is impractical, such as shallow reservoirs on major, agricultural or urbanized river systems, short-term management practices may have to be conducted annually. Even in such cases, however, under no circumstances should the complete eradication of aquatic plants be considered. This practice is environmentally unsound and could have very undesirable consequences. In some lakes it may be necessary to alter recreational activities somewhat to suit the lake's state of eutrophication, rather than attempt to change the lake to meet recreational demands. In situations where nutrient control is possible, short-term management techniques should be considered only as temporary measures, designed to replace nuisance plant species with plant species that conflict less with man's recreational and economic interest.

The short-term methods for managing aquatic plants include:

1) biological control,

2) mechanical harvesting,

3) environmental manipulation, and

4) use of herbicides.

These methods are directed primarily at the results (aquatic plants) of nutrients entering the lake and not at reducing the flow of nutrients. In some cases, however, nutrient levels within the water system may be reduced incidently with certain techniques.

## Biological Control

Biological control of aquatic vegetation is presently the least understood and utilized of the four short-term management techniques. Biological control normally includes the introduction of an organism that competes with, preys upon, inhibits the growth of, causes disease in or parasitizes a plant species which has created a problem.

The use of biological agents has many potential hazards. Therefore, the use of this control technique in either the terrestrial or the aquatic environment will always be under the direct supervision of state agencies. The introduction and release of exotic, foreign or non-native insects, fish or other animals into Michigan without specific authorization is strictly forbidden by state laws (Act No. 286 of the Public Acts of 1929; Act No. 196 of the Public Acts of 1958). At the present time, there are no specific biological control techniques being applied in Michigan waters.

## Mechanical Harvesting

Mechanical harvesting involves the pulling or cutting and removal of macrophytes from selected areas of a lake. It may employ hand tools or highly sophisticated motorized cutting or uprooting devices. The harvesting of algae from lakes appears presently to be economically infeasible primarily due to very high energy costs to remove the microscopic plants from water.

The removal of cut macrophyte material has advantages over allowing the material to decompose in the lake. Removal prevents dissolved oxygen loss and reduces the buildup of organic material on the lake bottom. Additionally, since macrophytes contain nutrients within their tissue, removal of cut material may somewhat reduce the level of nutrients present in the lake. However, in lakes that are annually receiving large amounts of nutrients from the watershed, nutrient removal by harvesting will have no or only a minimal influence in reducing the quantity of nutrients available for plant growth. But, in lakes that have had nutrient loading reduced, harvesting may remove enough nutrients to improve water quality.

Mechanical harvesting also has drawbacks which must be considered. It has a high initial investment if one of the specially manufactured harvesters are purchased. Many of these machines are large, heavy and can be damaged by obstructions (logs, boulders and debris) hidden below the lake surface. Additionally, harvesting could aid the spread of a plant problem, since cut plants may drift into unaffected areas, take root and grow.

## Environmental Manipulation

The objective of environmental manipulation is to alter one or more physical or chemical factors (listed in "Why Aquatic Plants Grow") critical to plant reproduction and growth thus making the environment less suitable to the plant. Several techniques have been used with varying degrees of success to manipulate the environment to achieve this goal. None of these methods are always economically and/or environmentally practical in every lake and even in practical situations should be employed only after careful consideration of the plant problem and social, economic factors. Environmental manipulation can provide some control of aquatic plants but without reduction of nutrient inputs, any results achieved will be only temporary. Since most of these methods are somewhat technical, only a brief discussion of each is given below.

Dredging reduces nuisance aquatic macrophytes by deepening the lake bottom below the depth of light penetration. Reduction of the size of the well lighted zone around the shore will reduce the total amount of germination and growth of macrophytes. The disadvantages of dredging include a temporary increase in silt suspended in the water, which on settling in non-dredged areas can smother bottom living animals. Additionally, land must be avail-

able for the disposal of dredge spoils. Dredging also may not reduce the level of nutrients available for plant production, therefore, algal populations may increase as macrophyte populations decrease.

Aeration is the introduction of air into the deeper waters of a lake for the purpose of increasing the dissolved oxygen concentration of the water and promoting oxidation of sediments. Aeration is most effective in lakes which are devoid of oxygen in the deep water. Keeping oxygen in the bottom waters will prevent the release of nutrients from sediments. As long as nutrients remain chemically bound to the sediments in the deeper parts of the lake, they are less available for aquatic plant growth. Decreases in nuisance algal populations and a shift to more favorable species have been reported following aeration, but this result is not always observed. A possible disadvantage of aeration is that it can be detrimental to cold water fishes (trout) if warm surface waters are mixed with cool bottom waters making the total lake environment unsuitable for these fish species. There are methods of aerating only the deeper waters, however. The use of an aerator may also cause the resuspension of bottom muds which may increase turbidity.

Nutrient Inactivation is the application of a chemical to a lake that binds with and otherwise immobilizes nutrients necessary for plant growth. Once immobilized, the nutrients settle to the lake bottom. The chemical substance used to immobilize and settle out the nutrients is usually a metal ion (iron, aluminum, calcium) though ion exchange resins, clay, mud, and fly ash have been used experimentally. The settling process may also reduce suspended solids and decrease turbidity and color, in addition to inactivating nutrients. This technique is expensive and may adversely affect the lake biology by covering the bottom sediments and fish-food animals with settling material.

Drawdown or water level manipulation is a potential mechanism for controlling certain types of aquatic vegetation. In this technique, water levels are lowered for a period of time to expose shallow water areas to air. This dries out the exposed plants and kills them. Many submergent macrophytes are susceptible to this procedure, but certain emergent macrophytes actually benefit from it. A drawdown period of approximately two months is necessary for drying and freezing to be effective during winter drawdown.

Dilution or Displacement of low quality water with water of higher quality may lessen aquatic plant problems. However, a supply of higher quality replacement water must be available as well as an acceptable means of disposing of lower quality lake water.

Shading for prolonged periods (4 weeks or greater) has been effective in reducing certain submergent macrophytes by light limitation. Light reduction through the use of water dyes has been tried, though this technique is still in the experimental stage. Black plastic sheeting has been used as a floating shade. Its success on small areas (swimming beaches) is good for certain submergent macrophytes and of limited control value for emergent vegetation. However, problems with wave action and currents limits the usefulness of a floating plastic shade primarily to small ponds.

Covering of Bottom Sediments with sheeting material (black plastic) and/or particulate material (sand, clay, fly ash) can perform two functions in controlling aquatic plants. It can prevent the exchange of nutrients from the sediments to the overlying water and it can retard the establishment of rooted aquatic macrophytes. Disadvantages of this technique are that bottom dwelling animals are usually killed when the sediment is covered and often gas is produced in the covered sediments, rupturing the bottom seal or causing it to float to the surface. Experience with this technique so far has resulted in only temporary control, since macrophytes will gradually recolonize the area.

Intensive Use and Periodic Manual Cleaning of shoreline areas will in many instances prove to be an effective means of aquatic plant control in small beach areas. The rooted plants must produce sufficient food in their leaves to maintain their root systems. Frequent cutting of the leaves or their destruction by wading and swimming will eventually lead to death of the root system by which the plants frequently spread. This technique is particularly effective with emergent vegetation and water lilies. Like weeding the garden, it is necessary to watch for the early development of potential problems and attack the plants as they become established and before they spread over large areas.

Use of Herbicides

Chemical control has, for many years, been the primary means of temporarily controlling aquatic plants. There are a number of chemicals available which offer varying degrees of action time, persistence, cost, selectivity and safety to humans, other mammals and aquatic animal life.

The best time to apply herbicides is during a calm sunny day after water temperatures have reached 50 degrees Fahrenheit, or when plants first show signs of growth. For lakes where a large segment of the surface area is involved in the treatment, the lake should be treated in sections over several days to avoid oxygen loss and consequently the loss of aquatic animal life as the plants decompose. Report immediately any environmental damage or death of large numbers of non-target aquatic animals (fish, frogs, crayfish, etc.) to the Department of Natural Resources, Division of Land Resource Programs, Inland Lake Management Unit, P.O. Box 30028, Lansing Michigan, 48909.

It is important that herbicides be used with extreme care. Those chemicals that are highly toxic to man require special handling such as protective clothing for application and posting of treated water so that innocent swimmers or fishermen are not exposed to potentially harmful chemicals. Before applying any chemical always read the product label completely and follow all instructions. Take special note of all warnings on the label to avoid any personal injury and dispose of all empty chemical containers as directed.

A list of commercial applicators licensed by the Michigan Department of Agriculture to apply herbicides and other pesticides to the aquatic environment is available from the Department of Natural Resources, Inland Lake Management Unit. Additionally, the Inland Lake Management Unit is available to answer questions which may arise concerning chemical control of aquatic plants or other aspects of inland lake management.

When herbicides are part of an aquatic plant management program, special care must be taken to protect both the environment and individuals involved, since herbicides are potentially dangerous to both. To promote the proper use of pesticides, state statutes (Act No. 245 of the Public Acts of 1929, Act No. 58 of the Public Acts of 1959, and Act No. 41 of the Public Acts of 1955) have granted regulating authority over the application of these compounds to the Department of Natural Resources. Therefore, a permit is required from the Department of Natural Resources prior to any chemical treatment of waters within the public trust or private waters which discharge to waters within the public trust. Application forms for a permit may be obtained from the Department of Natural Resources, Division of Land Resource Programs, Inland Lake Management Unit, P.O. Box 30028, Lansing, Michigan, 48909.

It is important to point out that the use of herbicides to control aquatic plants has many drawbacks, a few of which should be mentioned. Most herbicides control all forms of plant life to some extent, even those aquatic plants which are desirable may be killed along with the undesirable plants. It is also difficult to control the drift of herbicides, consequently plants may be killed over a much wider area than intended. Additionally, herbicides give very temporary control. For continual control, the treatments will have to be repeated for as many years as control is desired. In lakes where herbicides are used repeatedly on a large scale, dramatic shifts in plant populations can occur which may seriously alter the lake's ecology.

At the time of this publication, the chemicals presented in Table 3 are permitted for treatment of aquatic plants in the State of Michigan. Chemicals on the list may have many trade names.

Table 3. Herbicides permitted for aquatic plant control in Michigan and the plant species for which they may serve as potential control agents.

| Plant species | Copper Sulfate | Chelated Copper | di(N,N-dimethyl-alkylamine) Salt of Endothall (liquid) | di(N,N-dimethyl-alkylamine) Salt of Endothall (granular) | Endothall | Diquat | 2,4-D | Simazine (used in ponds only) |
|---|---|---|---|---|---|---|---|---|
| **Algae** | | | | | | | | |
| Planktonic | • | • | • | • | | | | • |
| Filamentous | • | • | • | • | | • | | • |
| Macro-algae | • | • | • | • | | | | • |
| **Macrophytes** | | | | | | | | |
| **Submergents** | | | | | | | | |
| Curly leaf pondweed | | | | • | | • | | • |
| Sago pondweed | | | | • | | • | | • |
| Large leaf pondweed | | | | • | • | • | | • |
| Naiad | | | | • | • | • | • | • |
| Buttercup | | | | | | • | | |
| Coontail | | | | • | • | • | • | • |
| Milfoil | | | | • | • | • | • | • |
| Elodea | | | | • | | • | | |
| Wild celery | | | | • | | | | |
| **Emergents** | | | | | | | | |
| Water lily | | | | | | | • | |
| Arrow weed | | | | | | | • | |
| Cattails | | | | | | • | • | |
| Bulrush | | | | | | | • | |
| **Free floating** | | | | | | | | |
| Duckweed | | | | | | • | | |

Division of
Land Resource Programs
Michigan Department of
Natural Resources